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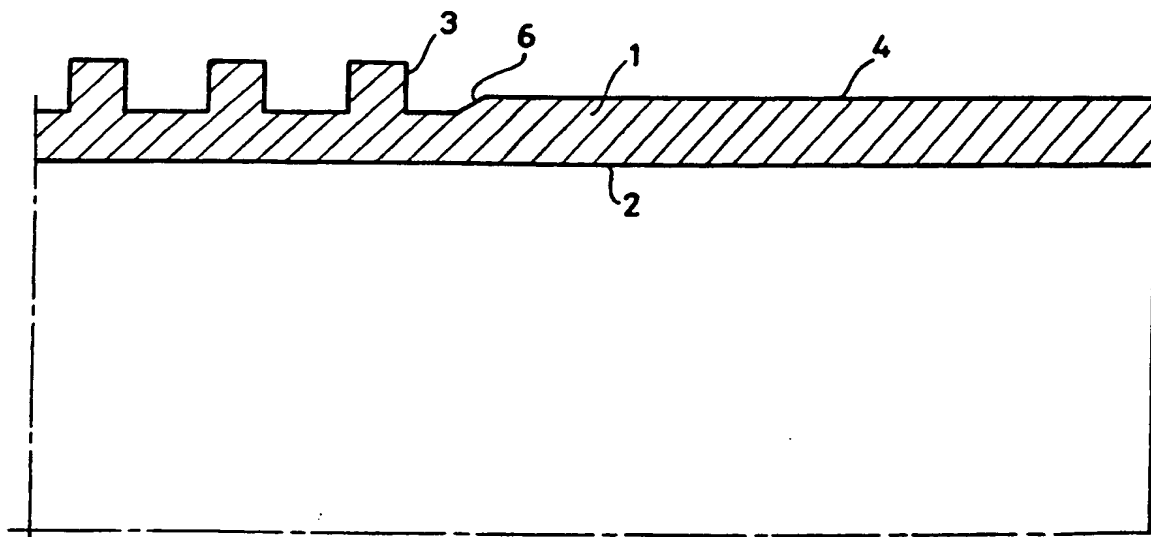
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(54) Title: **PLASTIC TUBE WITH SOLID CROSS-RIBS ON THE OUTER SURFACE, A MOULDING DEVICE THEREFOR; INSTALLATION COMPRISING SUCH A DEVICE AND A METHOD FOR MOULDING A PLASTIC TUBE**

**(57) Abstract**

The invention relates to a tube (1) having solid transverse ribs (3) at the outside and a smooth inner surface in which at least one end has a smooth outer surface (4) having a wall thickness which may be chosen free, i.e. greater than, equal to or smaller than the smallest thickness of the tube between the ribs. The invention also relates to a device for moulding a tube according to the invention, an installation having such a device and a method for producing a tube using such an installation which includes a device according to the invention. In the device at least part of the half-moulds used for forming comprises at least a smooth inner surface corresponding to a section of tube having a smooth outer surface.

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Plastic tube with solid cross-ribs on the outer surface, a moulding device therefor; installation comprising such a device and a method for moulding a plastic tube.

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Firstly, the invention relates to a plastic tube with a smooth inner surface and a solid outer surface comprising cross-ribs.

Such a tube is known from German Patent Specification 2,709,395. In said patent specification such a tube is described together with a moulding of such a tube. The tube described therein has a smooth inner surface and is provided with solid ribs on the outer surface over its entire length.

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Such a known tube which is provided with ribs over its entire outer surface has the disadvantage that connecting it to other similar sorts of pipes is relatively difficult. The usual widening, in normal smooth tubes, of one end in a manner such that the unwidened end of another tube fits therein has in practice hitherto not yielded satisfactory results in the case of tubes with solid ribs because the ribs are deformed during the widening operation which leads to uneven, non-round shapes which may be accompanied by a lessening of the mechanical strength.

25

The object of the present invention is to provide a tube provided with ribs with a smooth inner surface which is directly suitable for use in all known tube connection methods.

30

According to the invention such a tube is characterized in that at least one end of said tube has a smooth outer surface of predetermined length, said end having a wall thickness which is greater, equal to or smaller than the smallest wall thickness of the tube between the solid ribs.

35

In particular, the wall thickness is greater than the smallest wall thickness of the tube between the

solid ribs.

By making at least one end of a pipe according to the invention smooth and distributing at least part of the volume of the solid ribs normally present there equally over the wall thickness of the tube, a tube end is moulded, on the one hand, which is suitable for all normal joining methods while, on the other hand, said tube end may satisfy, in a simple manner, the required tolerances of roundness and strength.

10 In particular, in a tube according to the invention, the volume of plastic per length unit of the ribbed section amounts to 0.5 to 1.4 times the volume per length unit of the smooth section; in many cases, however, this ratio may be 1.0.

15 The transition section between the ribbed section of a tube and the smooth section of a tube is generally not sharp, but the transition section will have an incline; said incline is generally between 0 and 90°.

In the case of many types of tube connection it is usual to widen one end of the tube in a manner such that an unwidened end of another tube may be suitably received therein; as a rule, use is made of sealing means which are appropriate for this purpose. The tube according to the invention may then, at its smooth end, be widened in a manner such that an end comprising solid ribs of another tube may be received; the widening may also be produced in a manner such that an unwidened smooth end of another tube may be received. In the latter case, the tube according to the invention will have a smooth outer surface at both ends; one of the two ends will then be widened in a manner such that a smooth end of another tube may be received.

The invention also relates to a rib-shaped device for use in an installation for moulding a tube comprising ribs according to the invention as described above, which device comprises at least two series of half-moulds; each half-mould having a half-tube-shaped moulding cavity, and the half-moulds being moveable along tracks, which

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tracks run parallel to each other over a working path in a manner such that, over said working path, the half-moulds complement each other, during moulding, to an annular mould around a concentrically arranged smooth mandrel. The  
5 device according to the invention being characterized in that at least one pair of all pairs of half-moulds is present, at least a section of which has a smooth inner surface, whilst the half-moulds in the remaining pairs have a ribbed inner surface.

10 For such a device according to the invention it is, furthermore, the case that, in particular, at least one of all pairs of half-moulds is present, at least a section of which has the smooth profile which is not parallel to the surface of the above mentioned smooth  
15 mandrel; said section has, at least partially, an incline of between 0 and  $90^{\circ}$  with respect to the central axis of the device.

The sum of the length of all half moulds with a smooth inner surface which is parallel to that of the  
20 smooth mandrel is essentially equal to the desired length of the surface of a tube with a smooth outer surface.

In particular, in the device according to the invention, the volume ratio per length unit of the moulding cavity of the half moulds with a ribbed inner surface around  
25 the mandrel to the moulding cavity of the half moulds with a smooth inner surface around the mandrel has a value in the region of 0.5 - 1.4; in many cases, said volume ratio is essentially equal to 1.0.

The invention also relates to an installation  
30 comprising an extruder and a rib moulding device as described above.

Finally, the invention relates to a method for producing a tube made from plastic with a smooth inner surface and an outer surface comprising solid cross-ribs  
35 using in an installation according to the invention as has been described above which is characterized in that the extrusion speed and the speed of displacement of the half-moulds of the invention are adjusted in relation to

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the desired ratio of the volume of plastic per unit length of a tube section with ribs and a tube section with a smooth outer surface and, similarly, the desired ratio of the displacement speed of the half-moulds is adjusted to a value in the region of approximately 0.5 to 1.4 times the extrusion speed.

If the ratio differs from 1.0, a constant speed difference is maintained over a period of time which is essentially equal to and coincides with the time that is necessary to permit formation, around a smooth mandrel, of the number of moulds having a smooth inner surface, which is required for the corresponding smooth section of a tube.

The invention will now be described with reference to the drawing, in which:

Figure 1 shows a tube according to the invention in cross-section, with a smooth outer surface at one end;

Figure 2 shows two tubes according to the invention connected together;

Figure 3 shows a tube provided with solid ribs, a central section having a smooth outer surface;

Figure 4 shows an installation for moulding a tube provided with ribs;

Figure 5 shows in plan view a section through a number of half-moulds of a device according to the invention.

Figure 1 shows a tube 1 with a smooth inner wall 2 and solid ribs 3 on the outer side. One end of the tube has a smooth outer side 4 while the transition section between the smooth section 4 and the section where the ribs 3 are located is indicated by 6.

Figure 2 shows two ribbed tubes connected together, 1 and 1', the smooth section 4 is widened in order to receive the section of the tube 1' provided with ribs; 5 shows that a packing material may be located between the ribs.

Figure 3 shows a section of a continuously moulded ribbed tube in which a section of the length has a smooth outer surface 4. In order to obtain tubes with a smooth

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outer surface at both ends the section 4 in the centre may be sawn through; if a smooth outer surface is required at only one end, sawing through may take place at one of the ends of said smooth section 4.

5           Figure 4 shows diagrammatically a device for the continuous moulding of rib tubes comprising a rib moulding device 10 and extruder 13.

          The rib moulding device comprises two endless belts 11 and 12 on which half-moulds 11' and 12' are  
10       mounted. The half-moulds lock together around the smooth end of an extrusion die ring 20 during moulding of an annular hollow form.

          The tube 22 delivered by the extrusion head 14 at the extrusion die ring 20 has a internal diameter  
15       which is smaller than the external diameter of the smooth mandrel 21. The half-moulds 11' and 12' deform the still plastic material, for example polyvinyl chloride, of the tube 22 and give the outer surface of the tube its profile.

          The moulds provided with a ribbed inner surface  
20       give a ribbed tube section 19. The moulds with a smooth inner surface lead to a smooth tube section 18. In all cases, the inner wall of the moulded tube is smooth.

          The extruder 13 is driven by a drive means 15; the rib moulding device is, as shown diagrammatically,  
25       driven by drive means 16. The two drive means are coupled via a control unit 17 which regulates extrusion speed and transport speed of the half-moulds in accordance with a desired ratio of the volume of plastic per length unit of a ribbed tube section and a smooth tube section.

30           The device sketched in Figure 4 shows a single extrusion head to which all necessary plastic is supplied in one delivery.

          Of course, with the aid of co-extrusion, the required plastic may be supplied in several streams to a  
35       special extrusion head connected to the rib moulding device, in which case the tube is constructed in stages.

          Finally, Figure 5 shows three cross-sections of moulds in plan view; mould 30 is a normal mould with

ribs 31.

Mould 32 is a mould with a ribbed section 33 and a smooth section 35; the transition section 34 has an incline.

5 Mould 36 has a smooth inner surface 37.

The invention will now be further illustrated with an example. A tube with an internal diameter of 180 mm with a wall thickness between the ribs of 2.0 mm is moulded in an installation according to the invention.

10 The height of the ribs is 7.8 mm, the width of the ribs is 2.55 mm and the pitch of the ribs is 16.9 mm. The surface of the cross-section of the tube is, on average, 1785 mm<sup>2</sup>.

The smooth end should have a wall thickness of 15 3.7 mm which corresponds with a cross-section of 2134 mm<sup>2</sup>.

This may be achieved by changing the ratio of the speeds of extrusion and transport of the half-moulds from 1:1 to 1:0.85 when the half-moulds with smooth inner surface pass through the zone in which the mouthpiece of 20 the extruder supplies a tube.

As soon as the last mould with smooth inner surface has been completed, the speed ratio may be returned to 1:1.

Throughout the description and following claims the term section means to indicate a length of tube forming a part of the total length of a tube.



CLAIMS

1. Tube made of plastic with a smooth inner surface (2) and an outer surface comprising solid cross-ribs (3), characterized in that at least one end of said tube (1) has a smooth outer surface (4) of predetermined length, said end having a wall thickness which is greater than, equal to or smaller than the smallest wall thickness of the tube (1) between the solid ribs (3).
2. Tube according to Claim 1, characterized in that the end with a smooth outer surface (4) has a wall thickness which is greater than the smallest wall thickness of the tube (1) between the solid ribs (3).
3. Tube according to Claim 1 to 2, characterized in that for a certain tube (1) the ratio of the volume of plastic per unit of length of a tube section which has solid cross-ribs (3) to the volume per unit of a tube section which has a smooth outer surface (4) lies in the region of 0.5 - 1.4.
4. Tube according to Claim 3, characterized in that said ratio is essentially 1.0.
5. Tube according to one or more of Claims 1 to 4, characterized in that the incline in the transition section (6) between the section of a tube (1) comprising ribs (3) and a smooth end (4) of the same pipe lies between 0 and 90°.
6. Tube according to Claims 1 to 5, characterized in that the end of the tube (1) comprising a smooth outer surface (4) is evenly widened in order to be able to receive an end comprising ribs (3) of another identical tube (1').
7. Tube according to Claims 1 - 6, characterized in that the end of the tube (1) comprising a smooth outer surface (4) is evenly widened in order to be able to receive an end with a smooth outer surface in an unwidened state of another identical tube (1').
8. Device (10) for use in an installation for moulding a tube comprising ribs according to one or more of Claims 1 to 7, comprising at least two series (11, 12) of

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of half-moulds (11', 12'), each half-mould having a half-tube-shaped hollow form, and the half-moulds being moveable along tracks, which tracks run parallel to each other over a working path in a manner such that, over said working path, the half-moulds complement each other with forming of an annular mould around a concentrically arranged smooth mandrel (21), characterized in that at least one pair (36) of all pairs of half-moulds has a cavity with at least a partially smooth inner surface (37) whilst the half-moulds of the remaining pairs (30) have a ribbed inner surface (31).

9. Device according to Claim 8, characterized in that at least one pair (32) of all pairs of half-moulds has at least a partially smooth inner surface (34) which is not parallel to the surface of said smooth mandrel (21); whilst said surface has at least partially an incline of between 0 and 90° with respect to the central axis of the device.

10. Device according to Claim 8 - 9, characterized in that the continuous total length of the sections of the half-moulds (36) which have a smooth inner surface which is parallel to the surface of the smooth mandrel is essentially equal to the desired length of a tube with a smooth outer surface.

11. Device according to Claims 8 - 10, characterized in that the ratio of the volume per unit of length inside a moulding cavity of a pair of half-moulds (30) locked around the smooth mandrel (21) which correspond to a tube section which has an outer surface comprising ribs to the total volume per unit of length inside a moulding cavity of a pair of half-moulds (36) locked around the smooth mandrel (21) corresponding with a tube section of the same tube which has a smooth outer surface lies in the region of 0.5 to 1.4.

12. Device according to Claim 11, characterized in that the volume ratio is essentially 1.0.

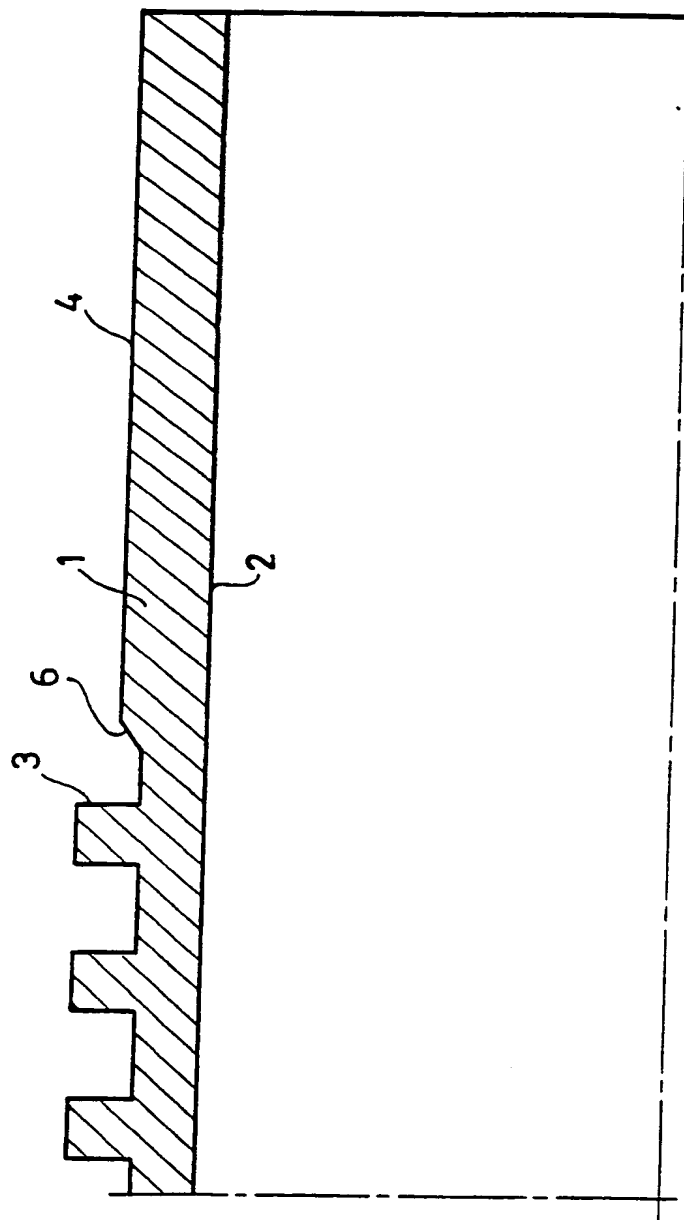
13. Installation for moulding a tube comprising ribs formed by at least one extruder (13) with an annular manifold and a rib moulding device (10) for use in such

- 9 -

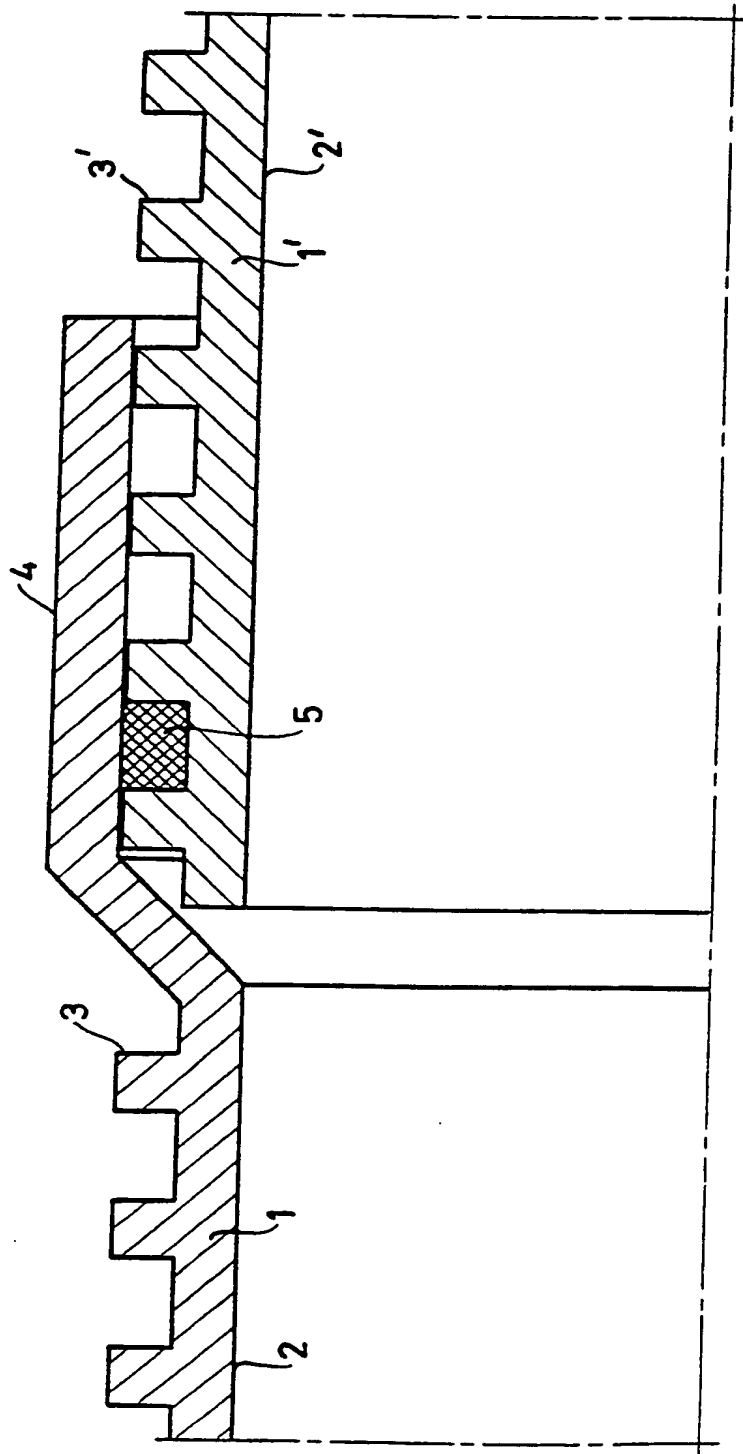
installation comprising at least two series (11, 12) of half-moulds (11', 12'), each half-mould having a half-tube-shaped moulding cavity, and the half-moulds being moveable along tracks, which tracks run parallel to each other over a working path in a manner such that, over said working path, the half-moulds complement each other during forming of an annular mould around a concentrically arranged smooth mandrel (21), said extruder providing a plastic tube, the internal diameter of which is smaller than the external diameter of said mandrel (21), characterized in that the rib moulding device (10) for use in said installation is a device according to one or more of Claims 8 to 12.

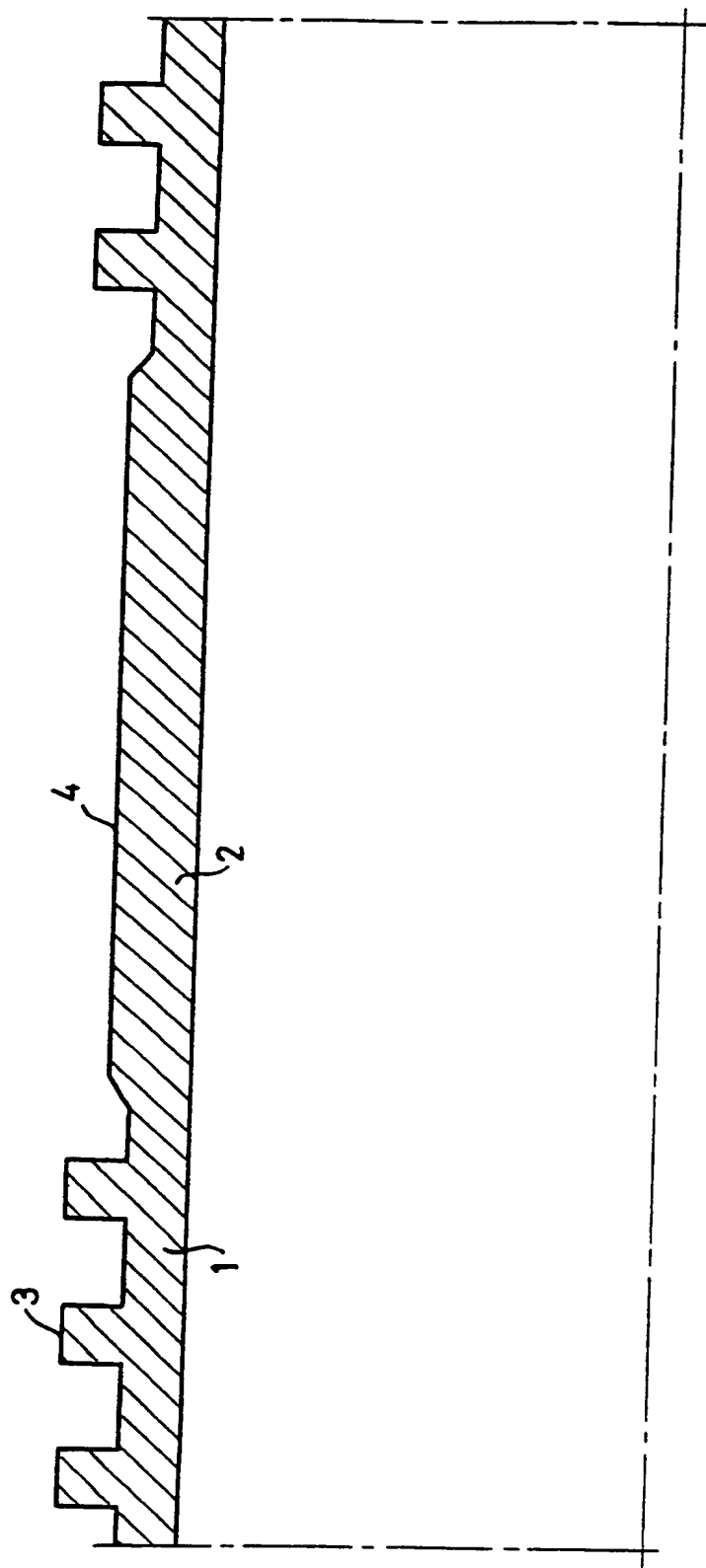
14. Method for producing a tube made from plastic with a smooth inner surface and an outer surface which has solid cross-ribs for use in an installation according to Claim 13, characterized in that the extrusion speed and the speed of movement of the half-moulds are adjusted in relation to the desired ratio of the volume of plastic per unit length of a section of a tube with an outer surface provided with solid cross-ribs to the volume of plastic per unit of length of a section of the same pipe which is provided with a smooth outer surface, if said ratio differs from 1, a constant speed difference is maintained during a period of time which is essentially equal to and coincides with the time period which is necessary to permit forming of the continuous length of the annular mould which has a moulding cavity with a smooth profile.

15. Method according to Claim 14, characterized in that, accordingly, the desired ratio of the speed of the half-moulds is adjusted to a value in the region of approximately 0.5 to 1.4 times the extrusion speed.

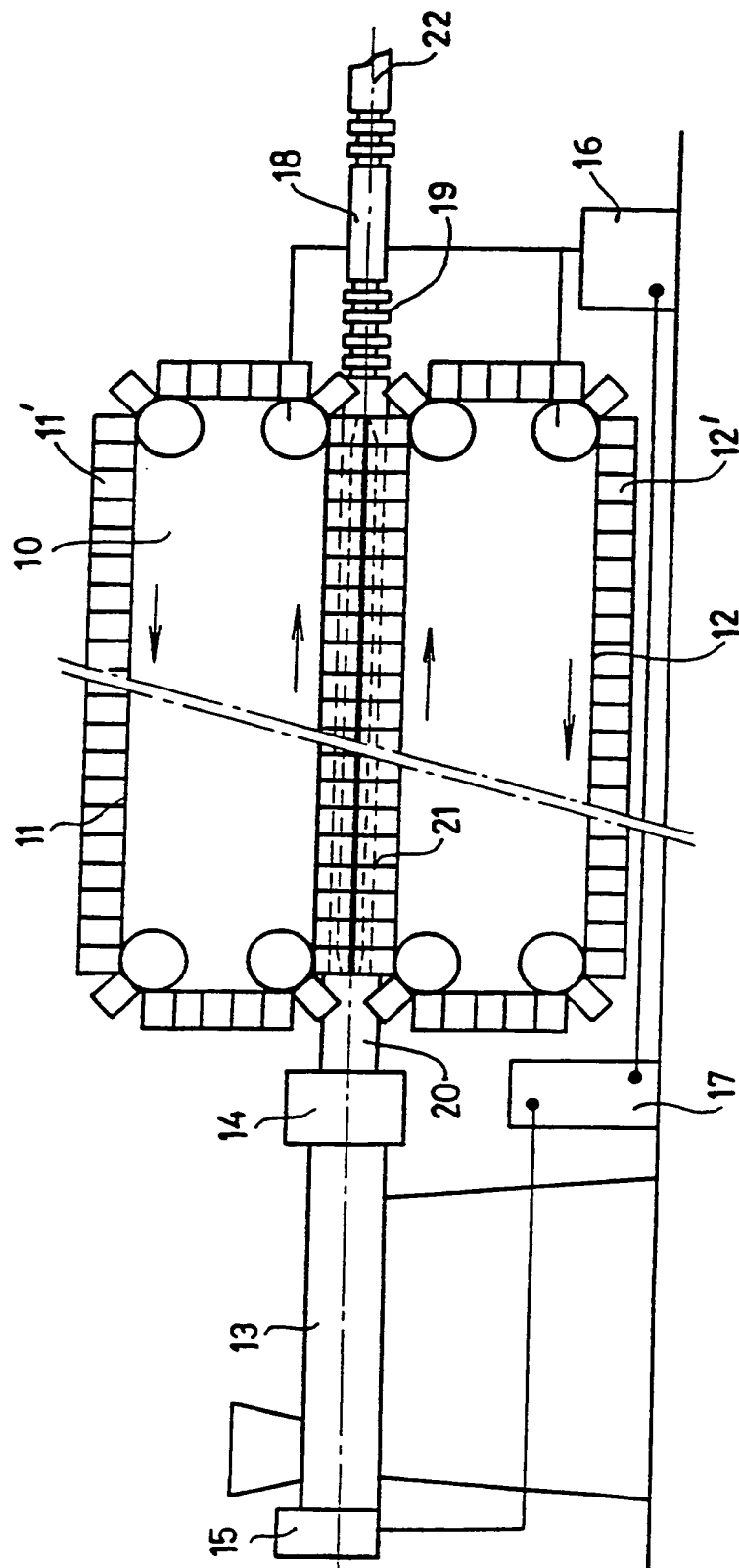


**FIG. 1.**

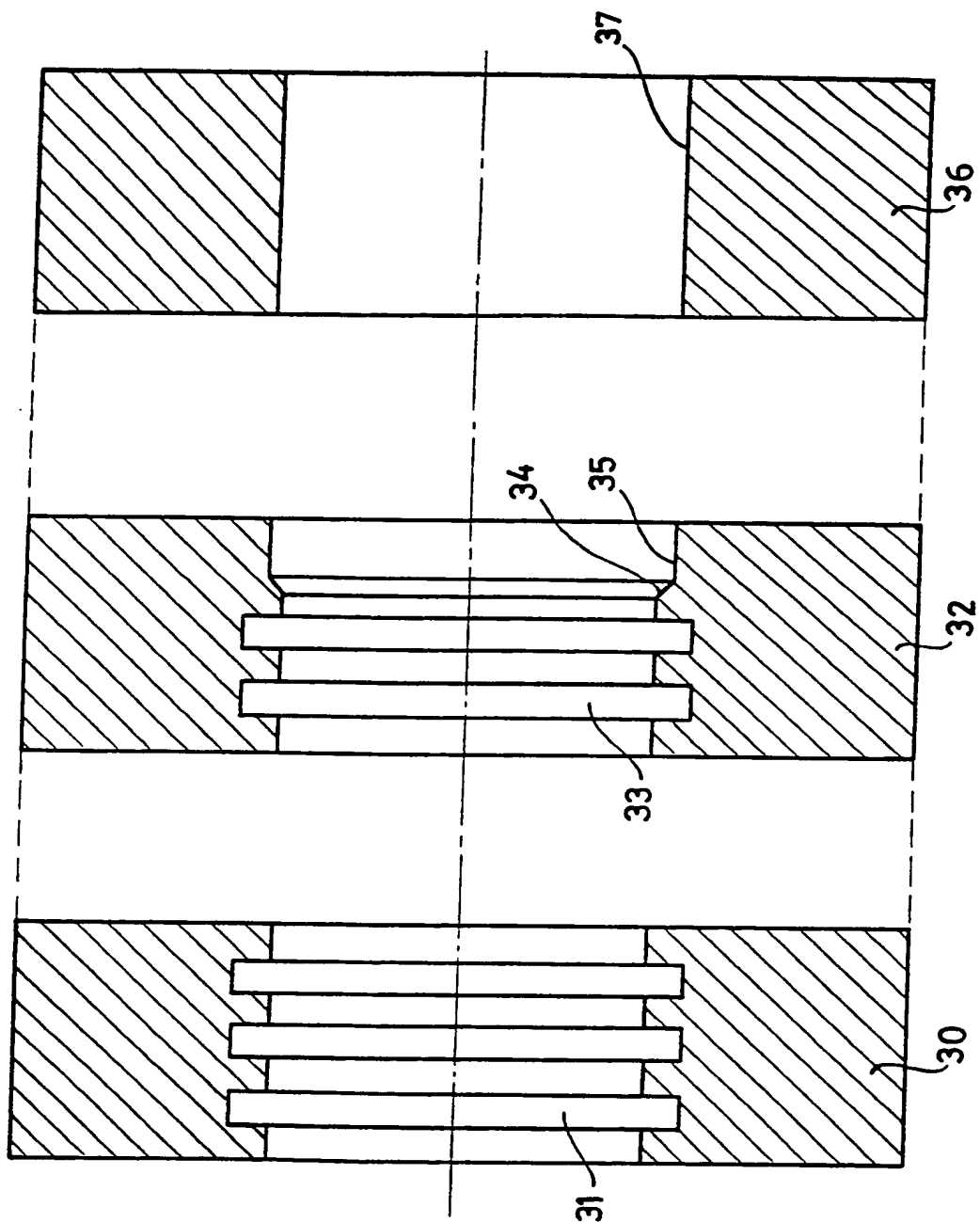
**Fig. 2.**



**Fig. 5.**



**Fig. 4.**



**FIG. 5.**



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/NL 88/00022

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) \*

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC<sup>4</sup>: B 29 C 47/00, F 16 L 25/00; // B 29 L 23:18

## II. FIELDS SEARCHED

Minimum Documentation Searched ?

Classification System

Classification Symbols

IPC<sup>4</sup>

B 29 C; F 16 L

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched \*

## III. DOCUMENTS CONSIDERED TO BE RELEVANT\*

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X	--	8-10
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A	--	1-4
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## IV. CERTIFICATION

Date of the Actual Completion of the International Search

23rd August 1988

Date of Mailing of this International Search Report

16 SEP 1988

International Searching Authority

EUROPEAN PATENT OFFICE

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## III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

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**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

NL 8800022

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